# WHAT YOU SHOULD KNOW ABOUT EYES

BY

PARK LEWIS, M.D.

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BY

PARK LEWIS, M.D., F.A.C.S.

*Vice-President, National Society for the Prevention of Blindness; Consulting Surgeon, Buffalo State Hospital*

NATIONAL HEALTH SERIES

EDITED BY THE

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## EDITORS' PREFACE

In the preparation of the National Health Series, the National Health Council has aimed to provide a series of twenty short books that would give to lay readers helpful and authoritative information about various aspects of personal and community health with which they should be familiar. The health of the individual in any given community is the sum-total of the forces that affect his life and daily living. Knowledge of body functions, together with an appreciation of diseases and environmental conditions that might impair the simple working of the human machine, is important if he wishes to keep in sound health.

There is necessarily a certain amount of desirable repetition in these twenty volumes, and certain books are of greatest significance to special groups. The books by Haggard, Rice, Laird, Pratt, Gillett and Tobey are fundamental to a sound conception of health and should be read by everybody. The volumes by De Normandie, Shaw, Bigelow and Galloway are especially designed for parents or prospective parents, tho they should prove also of equal value to educators and public-health workers. Other books in the series may prove of special interest to those who have or suspect they have certain diseases or impairment of special organs, but all adult readers will find them valuable.

In planning this series of health books, the editors have had in mind that certain age-groups, infancy, early childhood and adolescence need special consideration. The physiology of the body in general and in its relation to individual and to community health has also been carefully considered in separate books relating to the eyes, the ears, the teeth and the heart, and also to mental and sexual functions. Diseases that affect human health, particularly those that are preventable, are also treated in special volumes. The editors have had in mind, under each title, to

select an author of outstanding prominence and also one who could present his material in a manner that would be readable and comprehensible to lay people.

We wish to express our grateful appreciation to the various authors who have contributed to this series.

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# WHAT YOU SHOULD KNOW ABOUT EYES

## I

### THE MECHANISM OF SIGHT

SIGHT is essentially a process of the mind, because every object seen must be associated with our previous memories concerning it before it can have any meaning to us. We see objects only as they reflect light; and light, in order that it may be more than mere luminosity, must be focused in the form of an image upon the nerve elements in the retina.

Three essentials are necessary in the eye of all the vertebrate animals that sight may be produced:

1. A clear structure through which the light rays may pass.
2. A focusing apparatus by which the image may be formed.
3. The elements in the retina from which the impression is carried through the optic nerve to the brain.

That the eye may be properly protected, it is enclosed in a somewhat conical-shaped cavity with its apex in the skull. This shields it from injury on all sides. Some of the lower animals, such as the ox and the horse, have special muscles by which,

when the eye is threatened, it may be drawn back in the orbit out of harm's way. Nature has been exceedingly careful in protecting the human eye. Aside from the bony shelter in which it is placed, the lids cover it. The margins of the lid are armed with the lashes, which, when the lids are closed, tend to interlace, in that way preventing foreign substances from readily getting into the eye. The lids themselves, under the skin, have two sets of muscles, one a circular muscle by which the lids may be closed, another an elevating muscle by which the upper lid may be raised.

The lids are supplied with nerves by which their action is controlled. They automatically close when any foreign body approaches, and in this way they serve to protect the eye in a very large number of instances from injuries from which they might otherwise suffer. So quickly do they respond to this reflex action that before a knife aimed at the face could strike the eye, the lids have closed and the blow has been received upon the lid before penetrating the eyeball. The lids are lined with a delicate mucous membrane, the secretion of which allows them to glide over the ball smoothly and without discomfort.

### Nature's Use for Tears

A further protection is found in the lachrymal or tear gland. This is situated on the upper and outer portion of the orbit, allowing the tears to flow

over the eyeball, where they are gathered in two tiny tubes in the inner margins of the upper and lower lids and carried in this way into the lachrymal sac situated in the upper portion of the nose. When a cinder or other foreign substance gets in the eye it causes an increased secretion of tears, which will often succeed in washing it away. When the tears are in excess, as in cases of emotion, they pass into the lachrymal sac and down into the nose, causing the nose to run. Hence it is that at funerals and in emotional plays the handkerchief has to be used in blowing the nose, because of the excessive secretion of tears passing through it.

The front of the eyeball or clear portion is called the cornea. It is a continuation of the white layer of the globe, into which it is set, somewhat as the crystal is set in a watch. It is protected by a film-like membrane, which covers it and is highly resistant to the entrance of infective germs. It is only when this membrane is scratched or broken from an injury of any kind that infecting microbes gain an entrance into the deeper portion of the cornea, which may result in forming abscesses or ulcers.

Immediately within the eyeball is a vascular membrane with a background of dark pigment. In this are the nutrient vessels secreting the fluids upon which the nourishment of the eye depends. The innermost membrane is the retina, thinner than the finest tissue paper and yet microscopically consist-

ing of ten distinct layers. The innermost of these layers consists of the terminal nerve cells, which are of two kinds. They are distinguished as rods and cones, and altho much alike, their functions are somewhat different.

The place of most distinct vision is a small area of the inside lining of the eye, farthest back from the cornea, called the macula, which enables us in this area to distinguish form and color; at its very center this forms the sharpest pictures. In this sharp-vision area only cones are found. Surrounding this spot are both rods and cones, but the cones grow rapidly fewer until at the forward margins only rods are present. The rods give a clearer perception of light than do the cones. This may readily be seen by looking toward a faint star, bringing the macula or cone portion in the line of direct vision. By turning the eye a little to one side of the star, it will appear much brighter, as that brings it in the line of the rods. Both rods and cones terminate in nerve fibers, which are carried into the optic nerve and pass in that way to the back of the brain. Some of the fibers cross and some are carried direct to the back of the brain, in which is the sight center.

Both the arteries that carry the blood into the eyes, and the veins that carry it out, are seen in the retina, which is transparent. That this structure is visible is of great importance, because by means of instruments it is possible to see these vessels and to determine thereby the condition of the circulation

in other portions of the body and more especially in the brain and kidneys.

The extension of the vascular coat in front constitutes the colored portion of the eye, which for this reason is called the iris or rainbow. The pupil is an opening a little to the nasal side of this curtain. The action of the pupil, its shape and its responsiveness to light are often valuable indications of the existence of disease of the brain, even when no other symptoms are present. The pupil acts like the diaphragm of a microscope and automatically dilates or contracts to admit more light when the light is insufficient and to limit the amount admitted when the light is too bright.

The eyeball is filled with transparent substances of different degrees of density. That in which the iris floats, and which fills the pupil, has about the specific gravity of tears and is slightly saline. That occupying the back portion of the ball is the vitreous or glass-like humor, which has a jelly-like form and consistency. Between these is the crystalline lens, which, with the vitreous body and the cornea, forms the focusing apparatus.

Rays of light emanating from any object pass through the eyeball and are focused upon the retina and in that way are perceived.

In the normal eye these rays, emitted from a source at a distance of twenty feet or beyond, form a clear and definite image. In order that this may be regular and not blurred the curves of the cornea

and of the lens must be spherical. Should the curves in one direction be greater than those in the opposite one, a condition exists which is known as astigmatism, and the muscular effort necessary to correct the irregular focus resulting will often cause great discomfort and may even be injurious to the eye itself. The eye must be of the right length from the front of the cornea to the back, where the area of most distinct vision is found, in order that distant objects may be clearly focused without muscular effort. If, as frequently happens, the distance is too short, making the eye too flat, it constitutes what is known as the far-sighted or hyperopic eye. In the lower degrees this may not cause discomfort, but in the higher degrees it causes great strain of the delicate eye muscles, and in very high degrees, even with much effort, clear vision cannot be obtained.

### Cause of Near-Sightedness

If the eyeball is too long from the front to the back, it causes a condition known as myopia or near-sight. There are two forms of myopia, the congenital and the acquired. The congenitally myopic eye is too long from birth and may not change its shape greatly during life. Acquired myopia develops from a normal or from a far-sighted eye.

Myopia or short sight is one of the evils of civilization. It is not often found among savages or those who, like sailors, are generally looking at distant objects. It develops most commonly during

school life and is increased by continuous close work, such as fine sewing, lace-making, etc., especially when done in a poor or insufficient light.

Among all people there is a proportion of them whose eye tissues are susceptible to those changes which constitute myopia, and when excessive work is exacted it causes a congestion of the vessels in the posterior part of the eyeball, resulting in softening of the sclera or sustaining coat of the eye. In consequence of this, the eye stretches, and from a spherical organ allowing a ready rotation within the cone in which it rests, it becomes elongated. If the elongation advances to an extreme degree, the retina may become detached, and sight may be lost. Fortunately, a new operative technique has been developed which makes it possible to reattach the retina, so that sight may be restored.

The chief symptom of myopia is impairment of distant vision. One eye may be at first affected, and in that case the lowering of sight may not be detected until the eyes come to be tested. As soon as the second eye is involved, the student finds it difficult to read the writing on the blackboard from his seat in school. In the higher degrees of myopia the impairment of vision prevents him from seeing the features of his friends, and in reading he has to bring his book close to his eyes.

In the progressive form of myopia, near work must be discontinued. There must be little or no reading or writing. In many of the better schools

special sight-saving classes are formed, in which the eye work is reduced to a minimum and as much of the study as possible is done mentally. It is to be regretted that the ordinary school requirements are so exacting on the eyes. It would seem that methods might be employed in which all the study necessary could be included in the school day. Indeed, continued concentration of a growing child cannot profitably be extended beyond this limit, and in consequence much time is wasted in vaguely re-reading exercises that might be grasped at once if the mind were fixed upon them with economy of time and saving of otherwise wasted minutes.

When myopia develops, the child should immediately be sent to a competent eye physician, who will determine the amount of use to which the eyes may be safely subjected; and if the increase is to be controlled, his advice should be scrupulously observed.

## How Eyes Are Tested

In testing the eyes, a series of letters are employed, which are made on a graduated scale, and on which those of a specified size should be read at a definitely indicated distance.

These cards, which should be clean, with the letters clearly defined, should be placed at a distance of 20 feet from the person who is to be examined. Care should be exercised that while the letters themselves are properly lighted, no bright light shall

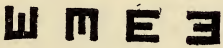
200 Feet

100 Feet

70 Feet

50 Feet

40 Feet



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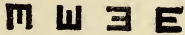

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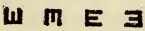

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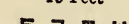

10 Feet

SYMBOL E CHART

shine in the eyes of the person being examined. These charts have upon them letters varying in size from one which should be seen at 200 feet to those which should be seen at 15 feet. The person to be examined should be comfortably seated with the feet touching the floor, so that nothing disturbs his attention as the test is being made. The left eye is then covered by holding a card before it, and the letters from the largest to the smallest that can be seen are to be read with the right eye. If the line marked 20 is read without difficulty, the vision is considered normal or 20/20; that is to say, the line which should be read at 20 feet is read at 20 feet. It is frequently possible to do somewhat better than this, and many will be able to read the 20-foot line at 15 feet, as the extreme of good vision is not used in the test. If, however, he is able to read only the line that should be seen at 30 feet, this is indicated by the figures 20/30, meaning that the line which should be seen at 30 cannot be seen at a greater distance than 20 feet. If nothing further than the 40 line can be read, this is indicated by 20/40, the 50 line by 20/50, etc., and if only the largest letter on the card, which should be seen at 200 feet, is read at 20 feet, the vision is represented by 20/200.

This formula does not mean that the sight which is retained is measured by these figures as *fractions*, because if the 40 line only is read at 20 feet, 20/40ths, if considered as a fraction, would be one-half. This would indicate that only one-half of the

sight is retained or that the person being examined is half blind, which is far from true. It is merely a method by which the examiner records, for purposes of comparison at a future date, the amount of visual clearness which is retained.

In a similar way the right eye is now covered and the test made with the left eye and the amount of vision recorded. It frequently happens that the eyes are quite unlike. When any record shows that less than normal vision is present in either eye, the person, whether child or adult, should be referred to a competent eye physician for a complete examination. It may be found that the lowered vision is congenital and permanent, and dependent upon some inborn defect within the eye. It may be dependent upon some refractive error, which should be corrected with glasses; or it may be dependent upon some diseased condition, the recognition of which would be of great importance.

Defects of the eyes are so often an expression merely of disturbed physical conditions that this can be determined only by those having medical experience. Such examinations frequently bring to light the existence of diabetes, Bright's disease, hemorrhages which may be precursors of apoplexy, and other conditions which it is most important to know and recognize. Whenever there is found less than normal sight in any eye which is examined, it indicates the necessity of an exact determination of the

causes to which it is due, as it may also be the forerunner of more serious diseases of the body.

## The Eye in Adolescence

When a young child's eyes are being tested to determine his acuity of vision it will be noticed that he rarely fixes his eyes for any length of time on the object at which he is directed to look. He will glance toward the letters or symbols that may be employed, but will immediately turn toward the eyes of the examiner as if to inquire whether his answer is correct—or as if seeking further directions. He has not yet acquired the power of fixity of attention. The eye muscles respond almost with the accuracy of the magnetic needle to the polar current as indicating the mental processes of the child. The thought of the child is fluttering from one thing to another. The mind itself is not yet under control. The eyes, which indicate, perhaps better than any other expression of his features, the action of his mind, wander indifferently from point to point. As the mentality grows stronger there will come greater power to fix his attention, and with this will come increased ability to control the direction of his eyes.

There is no better index of the power of concentration than that shown by the controlled action of the eyes. This is true not alone of the child. In the adult it is easy to determine whether one with whom we are conversing is understanding or not by

the way he looks at you. The intelligent listener has his eyes fixed on the speaker, for the gestures, the expression on the face; even the fleeting emotions may convey to the mind, unconsciously but instantaneously, far more than the words say. We may be instantly conscious that the spoken words may be the direct opposite of the feeling which the speaker has expressed.

We use our eyes far more than we know in the interpretation of the world about us, and it is through these subtle transferences of the inner thought that we develop what we term an instinctive attraction for or a repulsion from an individual. It is true, indeed, that the tones of the voice frequently carry with them meanings that are not expressed in the words used, but it is the eyes that serve us, perhaps to an even greater degree, in the recognition and reception of the finer emotions. In the consideration of the developing child it is necessary, therefore, to consider not alone the possibility of his seeing or not seeing objects, but, as well, the effect of imperfect or distorted vision on the child himself. Poor sight prevents his recognition of the world around him and may materially influence his development. Defective and strained eyes have impeded the work of many noted men and doubtless have limited the careers of others of whom we have never heard.

We now know from observations gathered from many sources, and from careful examinations, that

large numbers of children are born with defective eyes. For many of these, properly chosen glasses will give great help. For others, the amount of eye work which they may be permitted to do must be accurately specified. Inflammation of the lids or other weaknesses may be present. Any of these happenings may so affect the child's vision as to make special care of his eyes during his school years necessary. It is most desirable, therefore, that every child's eyes should be examined by a competent authority before the work of school life is undertaken. Defects may in this way be discovered and their correction may make a marked difference in the life of the child. The young myope whose world is otherwise vague and misty will be made to see things clearly and his mental picture will be changed thereby.

### The Pre-School Child

The examination of the sight of a very young child is not easy. It is quite possible for the eye physician to determine with accuracy whether glasses are required and what they should be, but visual tests require the cooperation of the child himself, and this is not easy to secure. The pre-school child has not yet acquired a knowledge of the alphabet. Indeed, children are not now taught their letters, but rather their phonetics and the sound of letter-combinations. While this is unquestionably advanced pedagogy, it would embarrass the work of

200 Feet

E

100 Feet

H N

70 Feet

D F N

50 Feet

P T X Z

40 Feet

F Z T D U

30 Feet

D F N P T H

20 Feet

P H N U T D Z

15 Feet

N P X T Z D F H

10 Feet

D Z H L N F T

LETTER CHART

the examiner, had not a better method been devised. For illiterate adults it has long been the custom to employ the letter "E," made in regularly progressive sizes and in accordance with certain rules of proportion, and the measure of sight is determined by the possibility of distinguishing the letters at a prescribed distance of 20 feet. Of course, it will not do merely to ask the child if he sees the letter or not, because in most instances the timid little thing will say "yes."

Some clever women who are connected with the National Society for the Prevention of Blindness have devised a very helpful method of examining these little ones' sight. The child, naturally timid in strange surroundings, becomes embarrassed and hesitant if frightened and refuses obstinately to say a word. Accustomed, however, to his mother or nurse, his timidity vanishes when the test is made into a game. The letter "E" is a funny little animal with three legs. His playmate, the examiner, standing at the prescribed distance of 20 feet, holds in her hand a large letter E, while an assistant seated by the side of the child holds an obstructing card before one of the little one's eyes. The funny animal is now held on its back, and the way that its legs point is indicated by an upward thrust of the arm. It is turned then with its open side to the right, and a recognition of this fact is indicated by the arm shooting to the right. Then the test is made to the left, then down. Then a smaller letter E is

taken, and a similar method is followed. Then another, until one is finally reached, the smallest in which the direction can be determined, the recognition of which registers normal vision. If, at any point before this, the child is unable to distinguish the direction in which the letter is turned, the degree of subnormal vision is recorded, and the child is sent to an eye physician for a more complete examination.

In this way, with a little instruction, teachers, nurses and even mothers of the children may discover the existence of defects which should be corrected. When the defects of sight are focal and glasses are needed, they should be given even at a very early age. They simply make the eyes function normally and may prevent a strain that not only affects the plastic developing eye-structures but may affect the general physical condition of the child as well.

### Strabismus or Squint

A very obvious condition which usually causes the mothers much concern is called strabismus or squint. It is that condition in which the eyes are not both directed toward the same object at the same moment. This sometimes affects both eyes, and sometimes alternates, affecting sometimes one and sometimes the other eye. When one eye is constantly turned in, the sight of that eye is invariably affected. In almost all cases of squint which have

existed for any length of time one eye will be found to have less clear vision than the other.

Squinting is usually the result either of not having glasses when they are needed, or of not having correct ones. It may be dependent upon anything that makes the sight in the two eyes unequal. According to the best authorities in perhaps three-quarters of the cases, it is due to far-sight or far-sight complicated with astigmatism. In this condition the eye is too flat, and the image can be brought into focus only by an excessive effort on the part of the focusing muscle. The eyes focus and turn in at the same time. When the excessive effort is needed to focus the eye at a near point, it is accompanied by an excessive degree of convergence, so that one eye turns in more than it should, causing it to squint. In order that a single image may be produced by both, it is necessary that each image should fall upon a corresponding portion of the retina. When one eye is turned in, the image that falls on the retina in that eye will not be upon a portion of the retina corresponding to that in the other eye. The effect will be, therefore, two images or double sight, which is exceedingly uncomfortable. To avoid this discomfort, the child learns to suppress the image in the less perfect eye, and in course of time this suppression becomes automatic and the eye loses its ability to see clearly. After a few years this loss becomes permanent, and the eye will always remain defective.

If the condition is dependent upon the need of proper glasses, the sooner the correction can be made the better. Since the focus of the eyes can be determined without the help of the child—by means of the shadow test which will be later described—proper glasses may be used at an early age. When that is done and the eyes are put in position to work smoothly together, they will very often gradually resume a parallel position. In cases where they do not, certain exercises may be employed by means of the stereoscope or other apparatus, which will retain the function of the defective visual center.

If it becomes evident that treatment is not going to straighten the eyes, an operation for the readjustment of the muscles may be successfully employed. The deformity is so obvious that children suffer greatly who are obliged to go through school life without having it corrected, and since this can be satisfactorily done it should not be neglected.

## Sight-Saving Classes

Educators have come to realize that one of the first steps that should be taken is to determine the physical ability of the child to do the work required of him. Under the direction of the Departments of Health and Public Instruction, visual tests are being conducted and children with limited or defective sight are referred to some suitable authority to have the corrections made, when this can be done

by the use of proper glasses. Eyes so aided will usually be fully able to do the work required of those with normal eyes. Such adjustments, however, must not be made in a perfunctory way. It is of first importance that the glasses should be accurately adjusted to the defect which the child is found to have; that the frames be made to fit the face, with the centers of the lenses directly before the centers of the pupils, and that, especially when astigmatism is present, the frames be not allowed to get out of position by being bent out of shape, as they may then aggravate the condition that they are expected to relieve.

When all such cases have been corrected, many children will be found with sight still so defective that they are unable to meet the class requirements. This may be due to early inflammations that have left behind them scars before the pupil or other defects that prevent the child from seeing what may be written on the blackboard or compel him to hold his book very close to his eyes. There may be other conditions, such as progressive near-sight, in which the ordinary school requirement, if persisted in, will inevitably increase the disease until even blindness may supervene.

For children having conditions such as these, obviously the usual class methods are not suitable. Tho fully able to meet the intelligence tests suitable to their ages, the handicap of limited sight will so impede the progress of the children as not only to

retard their own advancement but as well to make them a drag on their normal-sighted classmates.

In these special cases it has been found expedient to establish what have been termed "sight-saving classes." There are usually not a sufficient number of these children in any one school to make it necessary to give them special instruction; but by taking those so limited from various near-by schools, a sufficient number will easily be found to make a class, to which more individual training may be given. In the United States there are at present 477 such classes.

For the use of sight-saving classes, special textbooks are printed in large, clear type, on soft-toned paper; special pens and pencils for making large characters on paper are provided; special maps and globes are used. Arithmetic is taught largely by oral drill in figure combinations, and the problems are read to the class or written in large letters on a blackboard. Care is taken to choose classrooms that have plenty of light but no glare. The walls have a dull finish. Movable desks are used, and no high lights are anywhere present. The children are taught not to sit facing a glaring light, nor to read in bed, and to sit so that the light comes over the left shoulder in reading or writing, for right-handed pupils, and vice versa for the left-handed.

## II

## GLASSES AND THEIR USES

THE correct fitting of glasses is an art. It is most important that refractive defects, even when small, should be accurately corrected. To do this requires much time and patience on the part of the examiner, and in dealing with young children he should have the complete cooperation and assistance of the parents or friends by whom the child is brought. An appearance of haste or a slight feeling of irritation on the part of the examiner, even if not openly manifested, is quickly felt by the timid child, who becomes confused and frightened and uncertain in his answers. If the least severity is used, the child will often burst into tears, and then all hope of getting his aid is out of the question. The parents at such times are apt to become impatient and forcibly to make the child respond to the examiner's questions. This, of course, will always make matters worse. The little one must be made to realize that no harm is intended; that no sudden or unexpected motions are going to be made, and that the strange instruments which he sees on every side are not going to hurt him. After having obtained the child's confidence, a mere inspection of the eyes will often assist the experienced examiner in determining what condition is present.

There may be a sensitiveness to light, with a blinking and winking of the eyes. The eyelids may

be reddened and watery, which may be evidence of the presence of a catarrhal condition or of adenoids; or there may be a slight turning of the eyes inward, or even a marked squint.

There are two ways of determining the existence of refractive defects in the eyes. One is by looking into the suspected eye with proper instruments and finding what glass will enable the examiner to see the finer structures in the background; the other is to place various glasses before the patient's eye until the one is found that enables him to see most perfectly—by adequately correcting his defect. For the very young child the first is the only available method, because he is unable to tell us how much he can see, and the same lens that enables us to see into the back of the eye will make it possible for him to see distant objects. In this way we treat the eye as if it were simply an optical instrument.

As we look into the eye, the pupil appears to be black, altho from front to back it may be perfectly clear. It is quite the same if we look into a deep well. We see nothing but the dark surface altho we know the water to be quite transparent. This is because the light is not reflected back to our eyes; but if we direct the rays of a searchlight into the well, we clearly see the bottom. This principle is employed in the ophthalmoscope, the instrument invented by the great scientist, Helmholtz, and now widely used in examining the eyes.

The examination is made in a dark room, so that the diffused light may not interfere. A small mirror, perforated in the center, is held a short distance from the patient's eyes in such a way as to reflect the rays from an electric light into his pupil. The rays, thrown in a straight line, come back again to the opening in the mirror, through which it is possible to see the illuminated back portion of the eye. The pupil then is no longer black, but red, because of the reflection from the red blood-vessels back of the retina with which the eye is lined. It is then quite possible to see the entrance of the optic nerve as it joins the eye, with the arteries and veins spread out in different directions. The instrument is equipped with a rotating wheel of lenses that may be turned while the examination is being made. If the examiner's eye is of normal focus, or if it is corrected with a lense that makes it normal, the lens with which the background of the patient's eye is seen will measure his visual defect and indicate the strength of the lens that he requires.

To be successful, this method requires perfect relaxation on the part of the examiner's eyes as well as of the patient's. An experienced eye physician acquires the habit of relaxing his focus, but the patient usually has to have this done for him by the use of the "drops" which are put into his eyes. The drops commonly employed are made from the belladonna plant and have the effect of dilating the pupil and putting at rest the muscle which changes

the focus from the far to the near point. In young children—or in older persons whose eyes have been strained for a long time by a refractive error—this muscle becomes cramped, so that it frequently gives the impression of a condition quite different from that which actually exists. The eyes may appear to be near-sighted when they are really far-sighted or astigmatic, and if the prescription were made without relaxing the eyes it would be quite wrong and would increase rather than relieve the trouble for which it was given.

Another important reason for dilating the pupil in making these examinations is that when the pupil is small only a relatively limited portion of the interior of the eye can be seen. It is like looking through a little hole in a curtain into a room instead of lifting the whole curtain. Dilation brings all those parts of the eye in view around the extreme margins that would otherwise be hidden. It is often in these regions that the first evidence of disease is found. Especially is this true in the beginnings of cataract, when the first gray lines may be distinguished around the edge of the lens. Except in the very unusual cases in which drops should not be used—and these are readily recognized by the experienced physician—no examination of the eyes can be considered complete until this has been done. There are, it is true, very rare cases in which an unusual degree of sensitiveness exists to the use of

belladonna, just as some people are affected to an unusual degree by coffee or some other stimulant; but these cases are so infrequent, and the effects are so slight as compared with the great benefits that come from an examination with the pupil enlarged, that it should not be omitted.

In the eyes of young children this is especially true, and more particularly in the second method of examination, which is now very generally employed, and that by means of what is termed the "shadow test." With children too young to answer questions this is the only practical method, aside from the use of the ophthalmoscope; and indeed, in determining astigmatism or other irregular focal conditions, it is much superior. The shadow is obtained by the reflected light from a small mirror held in the hands of the examiner, who is seated at a distance of about 20 inches from the patient, and who reflects the light from the mirror into the patient's eyes. When this is done a shadow is reflected from the eye, which moves with or against the motion of the mirror as the eye is far- or near-sighted. It also gives the form of a band of shadow when astigmatism is present. By the movement of this mirror to a very exact degree, the focal conditions may be ascertained; but it is almost impossible to do this with accuracy when the pupil is small. It must be enlarged with the drops in order that an adequate shadow may result.

## The Optometrist or Optician

An optometrist who has been well trained in optics and in the fitting of glasses is in many cases able to make suitable adjustments insofar as refractive errors are concerned; but, lacking a knowledge of medicine, he is unable to determine the importance of other conditions that may be found in the eye. The business of the optician requires again a special skill and training, because, the prescription having been made, it is quite as important that the glasses shall be properly set on the face as that they shall be correctly prescribed.

It frequently happens that a slight tipping of the lens will throw it out of focus. Each lens, then, must be upon a perfectly horizontal line before each eye. Sometimes, indeed not infrequently, the eyes are not of the same height in the head. The two sides of the face are rarely alike, just as one shoulder is higher than the other or one hand or foot may be larger than the other. One eye may be more deeply set in than the other. The sides of the nose may be quite irregular, so that an ordinary nosepiece would throws the lenses quite out of adjustment. Often one ear is placed further back on the head than its fellow, and a frame of exactly the same proportion on each side would be quite unfitted for such a face. Special adjustments must be made to meet these irregularities, so that when the frame is fitted the lenses shall be accurately placed before each eye. The two eyes are frequently at different

distances from the center of the nose. This must be taken into account, and the lenses should be accurately centered in relation to the pupil of each eye. The position of the lenses will depend much, too, upon the kind of work that is to be done. For those engaged in reading or other close work they should be slightly angled and the range should be calculated according to the needs of the person.

For those beyond middle life an exceedingly convenient arrangement is what is termed the "bifocal lens." For the reading range, which should be about 14 inches, a stronger glass is required than for a distance of 20 feet. The bifocal arrangement which is now used is most convenient, but unless the lenses are carefully welded together a color line is seen at the point in which they join, which is most disagreeable.

A new and convenient arrangement is to have the bifocal addition placed in the form of an oval or a band welded in the glass at the reading range. This proves to be most satisfactory, as a large part of the glass is not used in reading, and it leaves the lower portion free, so that the blurring produced by having the shorter range occupy the whole space is avoided. All makers do not use the highest quality of glass in making lenses, and in the process will be found those that have flaws or that are wavy or have other imperfections. These are frequently sold to cheap dealers and may cause mischief. It is as necessary that our glasses should be kept clear as

that our windows should be kept clean. A soiled lens is an imperfect one. Some soft substance, such as silk or fine tissue, should be readily available so that the finger-marks may be easily wiped off. If glasses are removed frequently, they readily get out of adjustment. If cemented lenses are used, the cement in time dries between the layers of glass and a blurred surface results. In such cases the segment should be removed and recemented so that both lenses may be kept clear and in proper condition.

When the eyes are a little sensitive it will sometimes be found that tinted glasses modifying the light will add to the comfort, but unless for special reasons required, the eyes should not be sheltered too much from the light or in time they grow more dependent upon the protection and are unable to bear ordinary daylight.

There is one blind spot in every eye—where the optic nerve enters the eyeball. This can easily be discovered by closing one eye, the other being directed straight ahead, and holding a pencil with a white top at a distance of 14 inches. If it is moved slightly to the outer side and below the line of direct vision, at a certain point the top will be found to disappear. This is the point where the image falls upon the optic nerve, in which there is no sight.

Floating objects within the eyeball throw shadows on the retina which appear like moving objects. When suddenly a black body like a fly appears before one of the eyes, especially if with it there

is some diminution of sight, it may be due to a hemorrhage within the eyeball. This is not like the little chains of semi-transparent globes which we see on looking toward a cloud or white surface. These are normal and are found in everyone's eyes. They are the shadows of minute floating particles and are not indicative of disease.

The use of glasses to enable people to see better is, of course, very old. It is said that glasses were employed by the Chinese centuries before they were known to Europeans, and even Nero, who was said to be exceedingly near-sighted, used a lens in a ring in order that he might witness the sports in the amphitheater. The refinement, however, in the application of lenses and their very accurate adjustment for the correction of focal errors dates back but little further than the beginning of the present century. It was largely due to the careful studies of American physicians that small amounts of astigmatism were discovered to have so profound an effect on the general physical welfare. Since then all progressive physicians have recognized the important fact that the eyes, which are actually extensions of brain tissue, when organically or functionally unfitted for the work which they do, as when improperly fitted with glasses, may give rise to remote nervous disturbances of a most profound character.

It is not only hypersensitive people whose nervous symptoms are relieved by suitable glasses. The

busy man of affairs or the workman, on his truck, after swaying from an attack of dizziness which made him apprehensive of some dreadful oncoming fatality, has often found these properly selected lenses to give him complete relief. After "tromboning" in a vain endeavor to read the morning paper or to distinguish the difference between the twos, the threes, and the eights in the badly printed telephone book, he will not be willing to relinquish the sight-giving glasses that bring the type out in clear and definite form. Nor even will the myopic little child who, unaided with proper glasses, is unable to read what is written on the blackboard in school, and who buries her face in her book in order that she may see the print, be willing to "throw away" the glasses that make the world so clear and beautiful for her.

Not many of those of us who have been incapacitated for days by racking headaches which suitable glasses have dissipated would be willing to exchange the material help for the old pain. Even, in many cases, inflammations within the eyes have been aggravated and intensified by the strain of an effort to focus them which could have been readily relieved. The benefit that has come from the use of glasses is so widespread and is so generally recognized both by physicians and by patients everywhere, that the advice to discard them, which we sometimes hear, meets with but scant approval.

And yet, as with many extravagant ideas, there

is a sufficient substratum of truth in the crusade against glasses to lead a certain class of by no means unintelligent people to seek an authority which will allow them to discard an artificial aid that to them appears obnoxious. There has during the last few years been a continuous effort on the part of the makers of spectacles to develop in the public mind what is termed "eye consciousness." This has been emphasized by the examinations which have been made of the eyes of school children. The relief experienced from glasses has been discussed in the homes and has served as a general topic of conversation. Manufacturers of lenses have commercialized this feeling and have largely succeeded in developing a public belief that all eyes are more or less defective, and hence should have the relief which glasses will give. This "eye consciousness" has led parents to feel that even if an examination develops the fact that a child's eyes are normal, still the use of glasses ought to give added strength to them, and they come to the eye physician asking for *rest* glasses, expecting in that way that a miracle will be performed.

## When Glasses Are Unnecessary

This widespread propaganda, and the fact that those who both sell and fit glasses are strongly tempted to urge the purchase of them even when they are not actually necessary, has led hundreds of people to use glasses when the correction of other

defects was really what was needed. Perhaps they were using their eyes at night and under bad conditions, with imperfectly printed books, and when physically in a condition which would demand rest rather than eye work; or perhaps, because of adenoids or catarrhal conditions, their eyes had become inflamed. Glasses are not the first aid required in such cases, and yet they have been sold and in some instances prescribed with the feeling that the small irritation might be benefited by the use of lenses. The consequence of this has been that numbers of people, children as well as adults, have had spectacles prescribed when other measures should have been adopted.

The extent to which this belief has been carried is exemplified in a printed statement made by a professor in one of the western universities, a man of great ability and eminence in his own line, who gravely states that he has observed that on the campus some of the students, of whom there are a thousand or more, are not wearing glasses, and that, "as it is quite impossible that their eyes are perfect, they should at once consult an eye physician in order that their eye defects may be corrected." That they should consult an eye physician is quite true, as the eyes should be properly examined to see if they are adequate before the intensive work of student life is begun; but that glasses must necessarily be prescribed, by no means follows. The absurdity of this lies in the fact that the eyes, like

other organs in the human body, are susceptible of adjustment; and while it is true, as an astronomer once observed, that if his optician were to bring to him an optical instrument having as many imperfections in it as are found in the human eye, he would refuse to accept it, nevertheless, these imperfections are by no means all of such a character as to incapacitate the individual for using his eyes with comfort and safety. This has been demonstrated by many intelligent people who have learned that there are instances in which glasses, when not needed, may be hurtful.

There are many people whose eyes are seemingly extraordinarily good—whose sight is exceptionally keen—yet for whom the use of properly fitted glasses would prove a great relief from nervous strain—an unsuspected strain often due to forcing the eyes to do work for which they are unsuited. There are multitudes of people whose imperfect sight prevents them from seeing the things which make life beautiful and worthwhile. There are numerous others for whom the use of properly chosen glasses are the necessary means for the correction of reflex nervous troubles, and whose headaches, indigestion, neuralgias or veritgos pass away with the relief of eye strain. But there are also many people whose eyes are perfectly normal, who have not yet reached the age in which the focal muscles have ceased to function properly, and who

are entirely comfortable without artificial aid. For these, such help is wholly unnecessary.

### Examination the Only Safeguard

Only after a full examination has been made, not only of the focal condition but of the internal structures as well, can one tell in which class one's eyes belong. Such examination may bring to light constitutional disease for which treatment should be promptly given. It will determine not only whether glasses are necessary, and if so, what lenses should be used, but how and when they should be employed; how they should be placed before the eyes, with many other matters related to their use. It will also determine whether the eye itself is free from disease. We will not hazard our good health, therefore, by throwing away our glasses until such examinations have been made and an opinion obtained from some one competent to advise whether or not they should be used—and how and when.

We should know, in order that glasses may be accurately prescribed, what are the conditions which make the use of glasses necessary. We have seen that a perfectly normal eye, up to the period of middle life, has no need whatever of artificial help, but that a large number of eyes are not normal. The shape of the eyeball varies, as do other organs. A vertical line drawn through the face so as to divide it into lateral halves will frequently show that the two sides are quite unlike. A noted woman,

whose bust is frequently sculptured, shows on the right side of her face a beauty and an intelligence that are entirely lacking in the left; the right, in consequence, is usually taken by artists for her profile view. This is probably due to the fact that the left side of the brain is much more developed than the right, and the expression which it controls is shown in the features.

The human eyes are normally so formed as to carry images of objects to the retina and thence to the brain without any conscious effort; but eyes that are malformed—and they are many—require an undue effort on the part of the focusing muscles. These conditions cause severe strain and consequently great discomfort. There is no way in which such abnormalities of form can be corrected except by the use of glasses made to compensate for the defects. To get clear vision in a bad case of myopia without a properly focused lens is an anatomical and physical impossibility, so that if glasses are laid aside under such circumstances, it is at the expense of sight. It may be possible for a person so afflicted to go stumbling through life without pain in the head and eyes, but there is no possibility of having clear sight unless the defect be corrected. The only condition in which glasses may safely be dispensed with are those in which they were either originally not needed or in which the need has passed away. Such cases can be determined only by suitable examinations made by a competent medical examiner.

# III

## WHEN THE MECHANISM GETS OUT OF ORDER

ANY of the various structures of which the eye is composed may become inflamed. An inflammation is indicated by adding *"itis"*—a word from the Greek—to the name of the structure. If the lids or "palpebrae" are inflamed we speak of the condition as "palpebr*itis*." If the inflammation is in the conjunctiva or lining membrane of the lids, it is called "conjunctiv*itis*"; if in the iris or part of the eye in which the pupil is placed, it is "ir*itis*."

### Conjunctivitis

The conjunctiva or con-joined structure normally secretes the mucus with which the eye is lubricated. In a condition of health this membrane is pink, but it has in it many fine vessels which, when an irritation is present, as of a particle of dust or cinder, become filled with blood. This gives the eye a reddened appearance. It may also be unusually dry, causing smarting, itching or heaviness of the lids; this is markedly increased in the evening, or when reading in an insufficient or too strong light. The habit of reading in the cars, where the jolting causes a constant change of focus, is exceedingly trying to sensitive eyes and may readily excite this congestion. It may be brought on by a smoke-filled

atmosphere, by reading in a bad position, by using the eyes for close work without glasses when they are needed, or by using improperly fitted glasses. It may, indeed, be brought on by any strain or irritation.

To relieve this affection it is necessary, of course, to remove the cause. Thus, if the position of a writer at his desk is such as to cause him to face a dazzling light, he should either change the position of his desk, or else shield his eyes with a protecting visor. Excessive use of the eyes should not be permitted. Usually some faulty habit or wrong physical condition will be found that should be corrected. In treating inflammation, hot fomentations laid on the eyes for five minutes at a time will often be found helpful. The eyes may be bathed with a solution of witchhazel or boracic acid. "Drops" of unknown composition and proffered by those who are ignorant of the eye should under no conditions be permitted to be employed, nor should the devices sometimes found in barber shops for massaging the face be used about the eyes. The first may carry infections from previous users, and the strong electric current or the pounding of the vibrating machine might do much damage in the hand of the unskilled user.

An inflammation of the conjunctiva is never to be taken lightly, tho it may, of course, be merely an accompaniment of a simple catarrhal "cold" which

is an infection of the mucous membranes; or, when associated with redness and a scratching sensation, it may be due to a cinder or other foreign body within the lids or upon the eyeball.

A common form of conjunctivitis is found in children and occasionally in older people who have obstructions of the nose. If adenoids are present they should be removed. If, as is not uncommon, the septum or middle cartilage separating the nostrils is deviated or bent so that breathing is obstructed, it should be straightened, as it prevents the outflow of tears and allows the secretions readily to become infected.

## Pink Eye

Among the common communicable infections, "pink eye" is one frequently met. It is sometimes spoken of as epidemic conjunctival catarrah. It is caused by a minute micro-organism and may occur at any age except in the first days of life. It requires about thirty hours for the infection to develop. It is frequently met in the fall and spring, is markedly contagious, and readily passes through a family or school. It begins with a mild irritation of the eyes and lids, but by the third day the eyes are very red, with small hemorrhagic spots showing. The lids are glued in the morning and become swollen and puffy. The eyes are hot, heavy and scratchy. The discharge at first may be purulent. It is best in

case of doubt to isolate the patient from contact with others. Until a physician is seen only the mildest remedies should be used.

### Trachoma

Trachoma is a disease in which the eyelids become granulated, thickened and red. It is infectious, and fortunately in the United States is confined chiefly to certain sections of the country. The Eastern States are almost wholly free from it. It has been disastrous to the eyes of mountain people remote from the cities in Eastern Kentucky and Tennessee, but through the efforts of our United States Public Health Service, in cooperation with the State officials and private efforts of public-spirited citizens, this distressing eye disease has been largely gotten under control. It is still rife in parts of Missouri and Illinois, and among certain of the tribes of Western Indians. It is widely distributed in Europe.

This, a controllable disease, requires vigorous treatment in the infected areas. With improved sanitary and hygienic conditions in the districts where this chiefly prevails, and active treatment of the individual cases, its ultimate disappearance may be confidently expected.

### Birth Infections

For many hundreds of years blindness was looked upon as a visitation from God and was accepted with fatalistic stoicism as something inevitable.

Even today, in the Orient and in some of the countries along the Mediterranean, we find the same apathy and reluctance to take the necessary measures to prevent the loss of the most precious sense we have.

In our own country, happily, the people are much more generally informed on sanitary matters, and there is a corresponding recognition of the dangers that may come to the young child's eyes; also greater intelligence concerning the necessity of prompt measures of treatment when the eyes are affected. The eyes of a new-born child, in certain of their structures, are not yet fully developed. In the growing process they are far more susceptible to injurious influences than they will be later, when they shall have become stronger and more fully adjusted to this new world into which they have come.

The baby is a sensitive plant. He must be shielded from the rigors of sudden changes from heat to cold and from darkness to light. The sun must not be allowed to pour upon his unprotected eyes. When it becomes necessary to touch them, they must be handled gently, and if "drops" are to be used between the lids great care should be exercised that the end of the dropper does not scratch the tender eyeball.

Up to the beginning of the present century, one of the most serious affections of a new-born infant was an inflammation of the eyes; for, if it was not

promptly controlled, it frequently resulted in the loss of the child's sight. And the pity of it, the horror of it, one might say, was that this terrible affliction was wholly unnecessary. It was one that with proper care was almost absolutely avoidable, and when right measures were taken, one that was curable. Because of the failure to recognize this fact, many hundreds of little children everywhere were obliged to grope their way through life, deprived, perhaps through their full three-score and ten years, of all the beauty of light and form and color with which our eyes are made glad.

### Saving the Baby's Eyes

It was left for a great obstetrician, Karl Siegmund Franz Crédé, of the faculty of the University of Leipsic, to discover the means by which these myriads of eyes might be saved and the happiness and effectiveness of thousands of people conserved.

It is not necessary here to describe in detail the manner in which this disease develops nor the essential nature of the infection. Let it be sufficient to say that when the mother is infected with the virulent germs, the discharges in the birth passages, getting into the baby's eyes as it is being born, are the seeds from which the infection grows. It takes several days for these to develop, however, so that in the days before a cure had been found, the mother, seeing that the baby's eyes were bright and shiny after it had been washed and brought

back to her bedside, naturally thought they were healthy and normal eyes. But after three or four days they would begin to grow weak and watery; irritating discharges would come from between the lids, and these would become swollen and puffed; and in the place of water, would come an outpouring of a thick, yellow, purulent discharge. If this were not promptly controlled it might go on for several weeks, and during that time the clear shiny cornea, through which the pupil can normally be seen, would become clouded and then break down in an ulcerated surface; and when the storm had finally swept by, instead of eyes there would be glaring, deformed, whitened balls from which the sight had gone.

Experiments had long been made for controlling this disease. About half a century ago Lister was making his epochal discovery of the microbial origin of disease, and Crédé and other obstetricians, as well as many eye physicians, were studying measures to prevent this frightfully disastrous condition. Finally it occurred to Crédé that silver nitrate, which was so useful in many similar conditions affecting the mucous membranes, might be effectively employed in preventing these birth infections of the eyes. But silver nitrate is an exceedingly irritating substance. Its other name is lunar caustic, and if used in too strong a solution or in too great amount it would injure the delicate eye structures themselves, as well as destroy the organisms upon which the disease depended. He used it, therefore, with very great

care, and in very definitely measured solution, in the obstetrical clinic connected with the university.

By means of a small glass rod with a tiny tip he dropped one drop of a 2 per cent solution in the eyes of every child born in his hospital. Used in this precise way, a slight irritation was produced, but the silver destroyed the vitality of the infecting germs. The little redness of the lids rapidly passed away, and in three days the danger was over. The treatment was dramatic in the effects which it produced. The children with infected eyes in that great clinic numbered nearly 10 per cent of all those born in the hospital, and the eyes of many of these had inevitably been lost. The silver was employed by this method in the eyes of every child born during the succeeding year. Of the 500 children only one developed a slight infection, and there was reason to believe that the germicide had not effectively gotten between this child's lids. An effective remedy had been discovered for one of the most serious conditions with which a new-born child could be afflicted.

It was found that the amount of silver which Crédé, in his skilled hands, might employ, was dangerous in the hands of those less qualified, and that many of the midwives were ignorant and careless; so the boards of health prepared for popular distribution small ampules, which were sealed from the air, and from which the light was excluded, as light would change the character of the silver and

make it inert. These were distributed gratuitously to all engaged in obstetrical work, and the physicians were urged to use the medicine in every case, as it might be safely employed and was sufficiently strong to destroy the activity of the germs. They were taught, too, that if the disease did develop through inertness of the silver or failure to use it properly, or because the infection had got into the eyes from some other source after the child was born, it was still quite controllable, so that with intelligent care the eyes might in almost every instance be saved.

Gradually the necessity of the care of the infant's eyes became generally known, and mothers would ask the doctors and nurses, immediately after the baby was born, if the drops had been employed; they would watch during the first few days that no inflammation developed in the baby's eyes, and if it did, would promptly seek skilled care, which could always be obtained, even if it were necessary to take the baby from the village or town into the city, where trained specialists were connected with public hospitals. The result has been most gratifying. Instead of 25 per cent of all the children who have become blind owing their loss of sight to birth infections, the proportion has been reduced to one-quarter that amount. Now, all but four States have some law or health department regulation requiring the use of a prophylactic at birth. The disease which used to be found so commonly in our hos-

pitals is now of such rare occurrence as to excite comment.

But indifference and carelessness will always exist, and the price that we must pay for the preservation of sight is eternal vigilance. Mothers will continue to have infectious discharges. It will continue to get in infants' eyes, and unless protective measures are employed regularly and promptly, eyes will be lost in consequence. So the propaganda must continue. People must be told of the dangers to which the child is subjected; they must be constantly informed as to the manner in which infections occur; they must be advised as to the measures that must be taken in order to save the baby's eyes, and in this they must have the complete cooperation of health departments, hospitals and dispensaries. Only then may we look hopefully to a time when blindness from this preventable cause shall be a matter of rarest occurrence.

### Prevention of Congenital Syphilis

Perhaps the most serious constitutional inheritance that a baby can have is that of syphilis. It so affects the elemental cells from which the body grows that the entire structure may be malformed in consequence. Such children have narrow jaws and are apt to have irregularly-shaped peg-teeth; the bridge of the nose is slightly sunken, and enlargements appear on the temples, giving the head a somewhat square appearance and making children

so afflicted look more or less alike. At any time in the life of such a child, altho usually not before the fourth or fifth year nor much after the twentieth, a deep inflammation of the cornea, the front transparent membrane of the eye, is apt to occur. This loses its transparency, becomes gray and clouded, and tiny blood vessels may be seen running through its substance. The trouble is exceedingly difficult to cure and is the cause of the loss of sight in a certain proportion of all the children found in the schools for the blind.

There has been discovered, happily, a preventive measure that is quite as effective as that used for infantile ophthalmia, of which we have just spoken. There have been very generally established clinics, at which the expectant mother may be advised in regard to her manner of living in order that she may bring forth a normal and healthy child. Where these clinics are not available, the services of an intelligent physician may always be secured. Every mother should see her physician or visit such a clinic and have a test made, to determine whether or not this serious infection exists. When it is found to be present, as it is in a considerable number of women, the methods of treatment now employed are especially effective. If, at any time within three or four months before the expected birth of her baby, or earlier if possible, the mother is placed under proper treatment, there is every reason to expect that she will bring forth a child free from the

syphilitic taint. At this perfectly normal, physiological period in her life, she is peculiarly susceptible to the curative effect of remedies, and if she undergoes a course—which need not be extended or difficult—she will be able to save her child from a lifetime of troubles incident to this inherited affliction.

The treatment just mentioned is one of the most important advances that have been made in the prevention of congenital syphilis. It should be widely known, and every prospective mother should be urged to take advantage of the treatment which is now so readily available.

## Accidents and Injuries

Altho the eye is well protected by the bony skull in which it is set and by the lids covering it, accidents occur much more frequently than they should. If cinders or other foreign substances become attached to the eyeball in such a way that they cannot be removed without the use of an instrument, medical assistance should be secured. Serious damage may be done to the eyeball by crude or inexperienced handling of these delicate tissues. The eyeball is covered by a thin, gauze-like membrane, the function of which is to protect the deeper tissues against the entrance of infecting organisms. When this is broken, an ulceration may develop, and if pus germs are present, an abscess or ulcer may be formed. The area of distinct vision in the eye occupies a relatively small space, and a small scar

left in this region may seriously impair the sight. It is important, therefore, that no more damage be done in the removal of a foreign substance than is absolutely necessary, because the larger the space injured the larger will be the scar and the greater the impairment of sight. An infection having once occurred, it may find its way into the anterior chamber or front of the eyeball. Such cases are always serious and require hospital care.

Deep injuries frequently occur in machine shops and other places in which metal is handled, by the failure of workmen to wear protecting glasses. Goggles are now made that can be adjusted to the focus of the workman's eyes, and the glass is of such strength that it is shatter proof. In many factories the use of these glasses in all dangerous work is insisted upon. In spite of that fact, however, it frequently happens that the glasses are laid aside and bits of flying metal penetrate the eyeball. By means of the electric magnet these are now sometimes removed, but such an injury is always serious.

Injuries which occur to the eyes of a child during the process of birth are much more frequent than has been commonly supposed. The bones of the head are as yet incompletely formed, and the pressure from the parts of the mother, especially if she be young and strong and if the child be her first-born, may be followed by injuries to the internal structures connected with the eyes. In this way the eyelids may be torn, or muscular attachments to the

eyeball may be loosened, or hemorrhages may occur within the eyeball itself. Sometimes a slight fracture of the skull will produce a hemorrhage in the brain, which may be followed by the drooping of an upper eyelid or a paralysis of the nerve controlling the muscle which draws the eye outward. Sometimes a careless examination on the part of a midwife may cause a finger to enter the eye of the baby, injuring it. Occasionally injuries occur which could in no way be avoided, and which may not show themselves until later. In this way double paralysis of the eye muscles may be caused, making it impossible for either eye to be drawn beyond the middle line, and giving the appearance of cross-eyes. Sometimes rapid twitching of the eyes results from such injuries, as well as defects of sight which are incurable.

While the baby is unable to move about and remains quietly in its cradle, there is ordinarily little danger of accidental injury to the eye, but from three to five years and later, with the child's great activity and little muscular control, it is very liable to hurt its eyes if allowed to play with sharp-pointed instruments. A penknife or a scissor blade is exceedingly dangerous in the hands of a child, and many of the accidents which occur are due to puncture-wounds from implements of this character.

Objects which are thrown, such as snowballs, stones, or any other hard substances, are not infrequently the cause of serious hurts through which

the sight may be lost. A dangerous game that the children engage in with sharp-pointed sticks, or the cracking of a whip that strikes the child's eye, may have disastrous consequences.

One of the most dangerous playthings which can be given to children is what is termed the "Beebe" gun or pea shooter. These toys throw a small lead shot with sufficient force to penetrate the eyeball. Accidents from this source are exceedingly common, and it would be well if such playthings were absolutely prohibited.

The Fourth of July constitutes an additional danger to the eyes as well as even to life and limb. Each year, hundreds are maimed by the careless use of firecrackers. Concerted effort is being made to limit the manufacture and sale of fireworks in order to reduce hazard from this source.

# IV

## THE EYE IN MIDDLE LIFE AND BEYOND

"WHEN persons in middle life or beyond have had their eyes examined by a competent eye physician, one of the first questions they are likely to ask is whether any evidences of cataract are present, and if so, whether it can be prevented or cured. Before considering this question it is well to know just what cataract is, and then it will be much easier to understand how it is produced. Many people mistakenly imagine that any visible opacity in the eye is a cataract. When such an obstruction is in the cornea or clear portion of the eye, it is usually the result of an inflammation in that tissue, usually an ulcer that has healed, leaving a scar in the form of a cloud at the site which it occupied. These scars or nebulæ, as they are called, are permanent and incurable. They may date from childhood and are not cataracts.

### Cataract and Its Prevention

A cataract is an opacity affecting the whole or a part of the crystalline lens of the eye. The lens is that part of the eye by which the rays of light are focused on the retina. It exists in all the higher animals as well as in birds and fishes. It is not a vascular structure, but is immersed in the aqueous humor—a watery fluid which fills the front chamber

of the eyeball, and which is secreted from the highly vascular tissues in connection with it. When for any reason the nutrition of this crystal-like structure is interfered with, either because of an injury to its vascular supply or from imperfect functioning of these structures, the delicate channels in the lens through which the lymph or nutrient fluid flows, become obstructed, and the fibers of which the lens is constructed lose their transparency. This most commonly occurs around the outer margins, and it is necessary that the pupil be widely dilated in order that the fine gray lines or striæ, as they are called, be discovered. Then, if a bright light be focused so that its rays fall obliquely on the lens, these lines pointing toward the center may be seen.

Opacities of this kind sometimes take the form of whitish patches. They may not always be marginal. They may be directly in the center of the lens. So long as they remain marginal, they do not obstruct the sight at all, and sight may remain perfect. As soon as the line of direct sight begins to be invaded, distant vision grows less clear. Often as this process continues the lens swells and the far-sighted or convex glass that had formerly been required for distant vision is no longer needed, or even a near-sighted glass may at this stage be found to improve the distant sight. Whereas magnifying lenses had been required before for reading, these may be laid aside, and an elderly person may be able to read a newspaper without the aid of glasses at all.

This is due to a hardening and thickening of the lens. It is a condition known as "second sight" and may ultimately shut off the sight altogether.

By means of one of the newer instruments of precision called the slit-lamp microscope, many of the finer changes which we were unable to see are now brought clearly into view. When the process of hardening has become complete, the lens that had before been as clear as crystal—hence its name, the crystalline lens—becomes completely opaque, and as it is behind the pupil, this opening, which before had been black because the light was not reflected from its fluid depths, now appears white. When this condition has been reached, if both eyes are so affected that reading is no longer possible and it is difficult to find one's way about, an operation for the removal of the obstructing lens may usually be safely performed. Under ordinary conditions, in the absence of other diseases within the eye, ninety such cases in one hundred, in the hands of a skilled operator, are successful.

After recovery, however, the eye will have lost the lens necessary for effecting a clear focus, and until replaced with a corresponding lens in the form of a strong and carefully chosen spectacle-glass, sight will continue to be dull and the objects blurred and indistinct.

But an operation is never an agreeable thing to look forward to, and it will immediately be asked, To what is this condition due, and can its progress

be stayed? May a cure be effected? These are important questions and must be fully considered.

In the first place, altho the opacifying of the lens in elderly people is called a "senile cataract," it is by no means the result simply of advanced years. Many old people go to their graves without experiencing it.

*An eye with beginning cataract is an eye that is giving evidence of local ill health.*

It may be, and very often is, an indication that the delicate balance that maintains the system in perfect condition is not functioning properly. It is a warning signal that should be heeded. The first cause of the disturbance should be looked for in the eyes themselves. Have they been struggling and straining under wrongly chosen glasses? If so, relief in the use of proper lenses should be afforded at once. Probably, however, this is not all the trouble. The channels, through which the nutrient fluid must be carried to maintain the perfect clarity of the lens, are so exceedingly minute that they have never yet been accurately determined; but if, as seems probable, the opacifying is caused by an obstruction of these passages due to some change of character in the fluid passing through them, then some noxious influence is affecting the nerves or the nutrient vessels around them, from which this fluid is drawn.

We have in the fluids of the eye a delicate chemical laboratory, which the introduction of a single

foreign element may contaminate. Happily, recent experimental and clinical researches have added important facts to our knowledge on this subject. An enclosed space in which is dead tissue, as around a tooth, will distil and allow to percolate into the blood—and from the blood into lymphatics supplying the eye structures—a toxin or poison that will be quite sufficient to disturb the delicate chemical balance absolutely essential to maintain a constant condition of health in the tissues. The slightest alteration in its consistency will be all that is required to clog the minute pathways in the lens into which it flows. This poison center may be and frequently is found in a decayed tooth, or in an abscess at the root of a tooth enclosed in the jaw. It may be in a diseased nasal sinus or cavity in the nose. It may come from a chronic pus-infected ear, or even from a diseased structure in so remote a point as the abdominal cavity—for instance, from a gall bladder.

Cataract, then, is not simply cataract. It is an evidence of a beginning degenerative change, a symptom indicating trouble elsewhere, which should be sought for and if possible relieved. It is often associated with other vascular changes, such as hardening of the arteries—symptoms which, for the lack of a better term, are generalized as "growing old." But, having removed the source of the trouble, has all been done that is possible? Unfortunately, a degenerative change having thus begun, the chan-

nels are no longer as clear as they were normally. The nutrient lymph fluid cannot as easily find its way into and out of the lens substance as before. The lens center, the nucleus, has grown harder, and a tendency to further obstruction, with increasing opacity, may be looked for.

To meet this, various measures are employed. One that is still in the experimental stage is the use of a preparation made from the lenses of the sheep or the pig. This solution is injected into the body with a view to stimulating renewed activity in the sluggishly acting vessels around the cataractous lens. This treatment can have value, of course, only in the beginning of the disease, and it cannot be expected to restore the transparency of the lens fibers which have been structurally changed. There is reason to think that, the cause having been removed, this treatment in some beginning cases has had value. Many of the most experienced eye physicians, however, refuse to endorse it as having even preventive efficiency. One thing is certain: It is a matter of first importance, when cataract threatens, to maintain the general health at the highest possible level by an abundance of fresh air and suitable rest.

The use of the eyes need not be prohibited if no other conditions exist which would prevent their moderate employment. Indeed, a certain amount of exercise of the stiffened tissues may be beneficial, but it should always be done under competent medi-

cal advice, as other conditions may be present which would make it inadvisable. When all these measures have been taken, it may be quite possible for a person with incipient cataract to go on for many years without so far losing his sight as to make operative measures necessary.

It is by no means always necessary, in the beginning of cataract, to tell the patient of its presence. The very word cataract usually carries with it a degree of apprehension that the condition does not warrant. It is so common to find in the lens small opacities which may never completely obstruct the sight, that it is often better merely to tell elderly patients that there are some small difficulties, which should be watched, but which need not cause apprehension unless they grow worse. But if the sight does become more obscure, and if there is a feeling on the part of the patient that he is growing blind, it is far better for him to know that it is a condition which may be cured by an operation, and that in a large number of cases such operations are entirely safe, quite painless, and not to be dreaded.

The operation consists in the removal of the opaque lens, which is no longer able to perform any useful function. It is simply obstructing sight. As it becomes more and more opaque, the connections which hold it in its position, and through which the nourishing channels pass, become less and less firm, and we speak of the clouding of the lens as a ripening process. It is very much like that through

which fruit passes as it matures. In the green stage the stone of a peach or of a plum clings firmly to the tissues surrounding it, and it can be taken out of the fruit only by tearing it away. But as the process of ripening goes on, the connections which held it in place, and through which the nutrient fluid is supplied, become dried and atrophied, and when the fruit becomes completely ripened, if it is broken open, it will be found that the stone is almost completely detached and can be taken away without any clinging to its surface of the fruit substance. It is much the same process in the ripening lens as it becomes a cataract. The lymph vessels which have kept it clear have gradually dried up, and the attachments which have held it firmly to the surrounding tissues have become loosened. The removal then of the obstructing lens becomes a fairly simple matter and is followed by little or no irritation.

While the operation for cataract is one of great delicacy and one that should not be performed except by those who have had experience in hospitals or otherwise, it is one in which, in a very large number of cases, successful results are obtained.

Injuries to the eyes may also result in cataract. A wound or a blow that interferes with its nutrition may cause a rupture of the capsule or outer coating of the lens, allowing the lens matter to ooze from the capsule in which it is enclosed, and permitting the other fluids of the eye to enter, causing it to

swell and become opaque. In such cases it may cause pain as the lens swells, and may require prompt removal by means of an operation.

## Glaucoma

The inexperienced are always in danger of mistaking for cataract another condition which requires prompt care and immediate treatment to prevent blindness, and that is "glaucoma." It may develop so slowly and painlessly that it may easily be taken for cataract. It consists in a slow hardening of the eyeball, and the pressure within the eyeball, in the course of time, unless it is controlled, will destroy the nerves of sight. It is distinguished from cataract by certain symptoms which are not always present, but which should be looked for. Among these are a rapid increase of the change of focus of glasses. Like cataract, it is likely to occur in those who are beyond middle life. It is very rare among the young. The tendency is often inherited.

Glaucoma is even more serious and more insidious in its onset than cataract. In its acute form it is painful and accompanied by rapid loss of sight. The pain, redness and blindness are caused by a sudden increase of pressure on the fluids within the eyeball. The condition is similar to that of an overcharged bladder which cannot be relieved, with the difference that the nervous structures within the eye are so constituted that intense pressure cannot be borne for any protracted length of time without

resulting in their permanent destruction. This acute condition, like an acute appendicitis, is fortunately remediable by *prompt surgical intervention.* Too frequently, however, the sufferer, believing that he is enduring a severe neuralgic condition which will soon pass away, postpones seeking the skilled assistance which he so urgently needs, until, when the pain finally disappears, his sight has permanently gone with it.

More dangerous, because less noticeable, is the chronic form of glaucoma. Frequently, at first, only one eye is attacked. It is often unaccompanied by pain. One of the early symptoms is the necessity of a too frequent change of glasses. There is a feeling with the most carefully chosen lenses that reading or other close work cannot be done easily and comfortably. In the evening a colored halo will surround the lamplight. There will be periodic attacks of blurring of one or both eyes. As the disease becomes more advanced, the field of vision will be narrowed, especially on the outer side. Then the pain will come, the eye will grow hard to the touch, and the sight will gradually fade away. The pupil is usually somewhat dilated.

If the serious error of dropping atropine or any other belladonna derivative is made, the aggravation of all the symptoms will be immediate and severe. Drugs which contract the pupil are required, as they give greater freedom for the passage of the fluids

of the eye from the posterior to the anterior part. A surgical operation on the eye is often required.

The cause of glaucoma is as yet unknown. Probably as in cataract it is another form of biological poison causing a chemical change in the eye fluids. The same care must be taken, therefore, to look for any focus of disease from which it could arise. The teeth, if any remain, should be X-rayed, and devitalized roots removed. Sometimes an unerupted molar may be dead in the jaw. It should be taken out. Even, at times, remnants of dead or necrotic tissue remain after the tooth has been extracted. In any event when the suspicion exists of the presence of this disease so fatal to sight, no time should be lost in securing the advice of the most experienced eye surgeon available.

## Iritis

In the acute form of glaucoma the inflammation may be mistaken for an inflammation of the membrane, the opening of which is the pupil. Often the distinction is difficult to make, even for those who are well informed. Iritis, as this disease is called, is accompanied by redness and great tenderness of the eyeball, by intense pain, often located in the temple on the side of the inflamed eye, and by distressing sensitiveness to light. It is frequently of rheumatic origin, and rheumatism itself is an infection coming from some diseased center, such as the tonsils, the teeth, or the nasal sinuses, in which

pus or some of the poisons absorbed from pus are apt to be present. The inflammation causes a gummy exudate to be thrown out around the pupil, and this in turn causes the margins to adhere to the lens immediately behind it. If not prevented, the exudate may completely fill the pupil and destroy the sight. To avoid this, atropine, which must never be used in glaucoma, is dropped into the eye. It dilates the pupil, drawing it away from the lens and keeping it at rest until the inflammation is controlled. Atropine is a very active poison and should be used only under medical advice.

## The Eye in Advanced Life

We no longer employ the term "old age" to describe the condition that comes with advancing years. The "lean and slippered pantaloon" is as obsolete as the words used to describe him. While indeed every year brings with it an added burden to be carried and a lessening of the vital energy, our increased knowledge of the art of living, of the bettered sanitary and hygienic conditions that have become universal in civilized lands, of bodily chemistry in its relation to disease, of the common infections and the manner of their avoidance, all these are of recent and modern development and have become common property. The result has been not only to lower the enormous infant mortality of the past century, but so to increase the individual resist-

ance to the undermining influence of wrong living that the hands of the clock are retarded.

While modern science has not quite succeeded, as Joshua is said to have done, in making the sun stand still, it has made the sun's annual rounds bear more lightly on the life of today. The woman of only a few generations ago at forty accepted resignedly the caps and bows which were the symbols of vanished youth. Today the keen, active woman of affairs is at the height of her usefulness as she approaches the half-century mark. Should her vital forces then begin to fail, it is but a warning to her that some of the avenues through which disease may enter have been left unguarded. And the man of seventy on the golf links or in the garden takes equally good and effective care of his bodily condition, seeing to it that the little beginnings of disease are met in time, and if not cured, at least stayed in their progress.

Inflammatory spots or tumor growths may come on the external structures of the eye with advancing years. The lids or eyeball may be reddened or congested, or even the nerves and arteries and veins deep in the eyeball may be involved. When for any reason there is the least lowering of sight with either of the eyes, the other being closed, which is not corrected with glasses, a complete physical examination with laboratory tests should be made at once.

Any small tumor is always of significance. If it is in either the upper or lower lid and can be felt

as a lump, it may be only a closed duct, and its contents, which are usually gummy, should be removed. If growing on the eyeball from the inner side, it may be a "ptergium" or bat's wing. It is likely to extend over the pupil, and if not removed before it has progressed too far, it will leave a scar and a distortion of the cornea with a diminution of sight.

An ulcerated sore with a thickening of the lid may be a skin cancer, which, if taken early enough, is usually cured by radium or the X-ray skilfully applied. A similar elevated growth on the eyeball should be removed and then treated with the X-ray or radium.

A beginning myopia in middle life means that the blood should be examined for the sugar of diabetes. A sudden attack of double sight may not be an indication for glasses, but for medicinal treatment or surgical intervention.

The information which may through this means be given to the family physician is of inestimable value and is often the first indication that medical care is needed.

Old age, then, is only another way of saying that the tissues of the body, and especially those of the eyes, are ceasing to function adequately. When the eyes get scummy and gummy-looking, blurred and dull, the first step should be to aid them to function without undue strain, and thus to build up their resistance. This aid is given by means of right

glasses, properly adjusted and regularly worn; by removing any toxic products, whether in the head or in the digestive organs; and by improving all the unsanitary conditions that may be found to exist, such as lack of fresh air, improper food and bad habits. Correct any psychic depressant, as far as possible, by replacing it with some helpful and interesting occupation, and old age, with its usual following of eye diseases and weaknesses, may often be so far pushed into the background that death may at last come quietly and gently, without any of these making their ugly presence known.

# V

## EYE INHERITANCES

### Will Her Children Be Blind?

"HAVE we reason to fear that, in the event of Elizabeth's marrying, any children she shall bear may be blind?"

This was the concluding paragraph of the letter over which the doctor was pondering as he sat in his study. It was one of the tremendous responsibilities which are put upon men almost daily, in which their decisions may change the currents of many lives. It involved that mysterious principle of heredity, concerning which so much has been learned in recent years, and about which so much is still unknown.

The writer, a successful business man in one of our larger American cities, was an excellent picture of robust health. Somewhat above the average in height and weight, clean-skinned, with a life history of superb health. His blood was free from the taint of disease. Among his ancestry on either side for three generations back were found none with marked defects of sight. His eyes were normal. His wife, a woman of good physique, was equally free—in her person and in the records of her forebears—of any reasonable explanation of the tragedy that had come into their lives.

Nineteen years before, their son had been born. The infant was perfect in every way except that the eyes were diminutive. Today the youth—tall, fine-featured, of athletic build, of unusually keen and responsive mentality, is almost blind.

The second child, a daughter, with all the charm of young womanhood, has arrived at an age when she may marry and bring children into the world. Hence the question, on the answer to which Elizabeth's future happiness may so largely depend.

It is necessary to recall some of the recent discoveries in the perpetuation of personal qualities and defects. It has always been known that resemblances are carried from the parents to the children in all forms of life, and that these extend, in animal life, not alone to the features, but to mental traits as well. There have been many popular beliefs as to the way in which peculiar characteristics are perpetuated. One which has not largely been given up is that of maternal impression.

In early history it is told that when Jacob tended his Uncle Laban's sheep and bargained to have as his own all those which were mottled and pied, he placed peeled sticks before them at the mating time in order that the offspring so marked should be increased. Whether or not this shrewed scheme resulted as desired we are not informed. Modern science, however, has something to say on the subject. After many observations had been recorded and many experiments made, it remained for an

Abbé in a little Austrian village to place our knowledge on a more exact, indeed on an almost mathematical, basis. Being of a scientific turn of mind, Abbé Mendel experimented with plants, and to make his results more certain he took two widely different varieties of a single species, the dwarf and the giant pea.

He established a principle to which only the briefest reference can be made here, but which has been followed by many careful experiments leading to a definite conclusion. These experiments have demonstrated that the generative cells, both male and female, from which the organism grows, contain qualities which are in pairs, and that when brought together they carry with them, in the resulting cell, traits which are reproduced with almost mathematical certainty. It is this principle that is employed in developing certain strains in cattle, horses and other farm animals. Some breeds of cattle are selected for their milking qualities, sheep for size, horses for speed or for strength. The development of these qualities is determined by the selection of progenitors which possess them. It was Dr. Holmes who said that if you wish to be a fine man you should choose a fine grandfather, thus humorously anticipating Mendel's conclusions. But the infant of today, in two generations, will be the grandfather; and by determining his qualities we are contributing to racial characteristics of the highest importance. It is a beautiful expression which the

Germans use in their correspondence when they address their letters to "the well-born" Mr. So-and-So. The quality named is one to which every child should be entitled.

The unborn child in the early embryo seems to be almost wholly head and eyes, and these important structures are especially susceptible to transmitted qualities; but in order that the qualities may be transmitted they must be inherent in the plasma cells themselves. Weismann cut off the tails of rats for generation after generation, but they continued to be born with tails. When they were kept continuously under the influence of alcohol, however, it took four successive lives before the taint was obliterated. "The fathers ate sour grapes and the children's teeth were set on edge."

Morgan made some exceedingly interesting experiments with the fruit-fly, in which he produced either red or white eyes at will. This little fly was chosen for experimentation because a new generation is produced in a few weeks' time and it is possible in a very few years to follow the development through many generations. In doing this he demonstrated that the eyes were particularly susceptible to changes produced by heredity.

In the human eye, defects of form are by no means uncommon. Nature occasionally seems not to have quite completed her work. The edges of tissues which should have come together to form a continuous structure, for some reason sometimes

suffer an interruption, and in consequence we find unfinished lids with gaps in the edges; even sometimes entire absence of the lids. In the case of Elizabeth's brother the entire eyeball ceased to grow before the infant was born, and, as in the case of Richard III, the child seems to have been rushed untimely into the world, so that instead of eyes showing intelligence and expression he had small defective bulbs; in extreme cases such eyes are no larger than peas and have little or no sight. In some cases the pupil, which should be a rounded opening nearly in the center of the colored curtain or iris, may be displaced far to one side; or instead of a single opening there may be two or three small openings for pupils. In other instances the two edges of the iris, which should have come accurately together while the eye was being developed before the birth of the child, have failed to meet, and the iris tissue is absent in the lower part, so that the pupil, instead of being a round opening, is carried down to the extreme lower edge of the colored portion of the eye. In this case the lack of tissue often extends through the whole length of the eye back to the entrance of the optic nerve, with a corresponding lack of sight in that area. In rare cases, the whole of the iris is absent, giving the appearance of a huge black pupil entirely covering it. Such eyes are apt to have defective sight and to be associated with other defects, so that the effort to see causes a constant, rapid oscillation of the

eyeball, as if it were struggling to find a clear place for distinct vision. A similar oscillation of the eyeball is common among miners who work in badly lighted tunnels with the eyes held in strained positions.

## Congenital Cataract

The most common of the eye defects are those in which the lens is—congenitally—partly or wholly opaque. The lens is normally directly back of the pupil, and when it is entirely opaque it gives a white instead of a black appearance in the pupillary space. This is known as congenital cataract. In a family under the writer's observation this defect was regularly transmitted from father to daughter and from daughter to son. In these cases the cataracts were successfully removed, giving to both mother and son very excellent sight. Frequently, however, while it may permit of successful removing of the obstructing substance mechanically, it is associated with defects in the deeper tissues, so that even when the pathway through the eye for the light-waves has been made clear, the sight secured may still be quite defective or wholly ineffective.

Cataract is not always acquired late in life. It may be an inherited defect. It is very commonly found in the schools for the blind. When congenital, a small amount of sight may be found present, or merely light perception. One form of cataract de-

velops shortly before or after birth, and in this the center of the lens is covered with a more or less opaque layer. If the light is focused through a magnifying lens into the pupil of the eye, the grayish surface may easily be seen. In order to make it visible, the pupil should be dilated. It is a condition frequently inherited and is often the result of similar conditions in one or both of the parents.

A marked instance is on record in the New York State School for the Blind, in which two congenitally blind people, half a century ago, married. Their progeny have been producing cataractous children from then to the present time. Seventeen, representing four generations, have attended the school just mentioned. The infirmity of these children is one which in some cases may be successfully operated upon, but usually there are other defects back of the cataract, so that even when it is safely removed, perfect sight is not present. The tragedy of those having such an inheritance to transmit is beyond estimate, and every effort should be made to prevent the perpetuation of such an unfortunate condition.

### Inherited Focal Abnormalities

Just as the two sides of the face may differ somewhat, or one shoulder be higher than the other, so one eye may not have the same focus as the other. Sometimes both eyes are too flat, and sometimes

they are much too long. These conditions are frequently inherited.

Among the animals, the absence of color in the skin, hair and eyes is a phenomenon of occasional occurrence. With rabbits it is common, but in birds it is rare. This condition is known as albinism. In the Museum of the Society of Natural Sciences in Buffalo there is a pure white robin. The phrase, "As rare as a white blackbird," is not without justification. In the human family, such color freaks occur probably in the proportion of one in ten thousand. It gives a most curious appearance in the negro, who retains the thick lips and flattened nose with white wool, white skin, and pink eyes with white lashes; sometimes only a forelock is white.

This feature persisted through six generations as a Mendelian dominant in a family whose records were carefully studied. A Mendelian dominant is a quality which is most apt to be perpetuated when present; a Mendelian recessive is one which is apt to disappear in subsequent generations. Albinism, through the absence of coloring pigment in the deeper tissues, allows light to pass through the part of the eyeball that is usually opaque, so that the light is reflected back through the pupil, giving it a reddish or pinkish instead of the usual black opening. It is not uncommon to find three or four albinos in a family, while the remainder of the children to the number of six or seven may be entirely

normal. Because of the absence of pigment, the eyes of albinos are exceedingly sensitive to light and have exceedingly poor sight. The effort to see causes them to twitch either laterally or in a rotating direction. Altho sufferers from albinism have usually sufficient sight to guide themselves, in reading they often see only the larger type, and this must be held quite close to the eye. In the absence of sight-saving classes in our city schools, a few such children are almost always found in the schools for the blind.

### Retinal Pigmentation

An almost directly opposite condition also is a contributing cause to the population of our blind schools. That is an excessive deposit of pigment in the retina. The retina contains the terminals of the nerves which carry light impressions to the brain. In its normal condition it is almost perfectly transparent. Occasionally children are born in whom degenerative changes begin to occur at an early age, with a deposit of black pigment beginning around its outer margins. As this progresses, sight is gradually lost, narrowing the field of vision more and more. Finally only the small center of relatively good sight is left unimpaired, and the sufferer from this defect has the impression of looking through a tube. This is accompanied by what is termed night blindness, so that even when fairly good central sight remains, in the twilight this is lost.

## Color Blindness

Color blindness is a much more common defect, and one which is also an inheritance; but it occasions serious inconvenience only when color differences need to be recognized. The eyes may be quite normal in every other respect, but may fail to recognize the distinction between the essential colors, red, green and blue. It is a defect that occurs in one of each hundred women and in four of each hundred men. The attention of the scientific world was first called to this condition by Dalton, the noted physiologist, who was himself color blind. To those who are unable to see a red color, not only are red objects seen as black or brown, but the red is eliminated from all objects in which it forms a part; thus purple is seen as blue. To the green-blind there is no green in the landscape; the grass and the trees are perfectly formed, but merely dark objects. Color blindness should be detected and recognized early in the life of those afflicted with it. It is an important factor to automobile drivers and railroad engineers.

One of the most serious conditions of an inherited character, and one that produces most disastrous consequences, is atrophy of the optic nerves. The infant may be born blind, these nerves being white and undeveloped; or they may gradually deteriorate during the earlier years of life. The optic disc, which may be seen in the normal eye as of a pinkish hue, with the nutrient vessels passing through it,

becomes as white as paper, the arteries and veins being hardly visible. It is a form of blindness in which sight is completely lost, no ray being perceptible. The eyeballs are otherwise quite normal in size and appearance, but the condition is, of course, hopeless.

As a diminutive eye may be one that fails of full development, so an enlarged eye, occasionally found, also is faulty in development. It has been termed, infantile glaucoma and is due to an essential defect of structure. In these eyes the sight is gradually lost.

The accepted dictum of eugenists seems to be "that the main characteristics of every living thing are unalterably established." When a definite defect exists, either in the form, the color or the structure of an organ, and this has persisted through several generations, it may be regarded as existing as a potential imperfection in the plasma from which the entire being is builded. This essential plasma, which every living creature carries, may be affected by profound extravenous influences, such as Stockard found by the continued use of alcohol, especially if one or both of the parents are under the effect at the time of conception. These defects may be either dominant or recessive. Their perpetuation and their extension will depend largely on the existence or absence of like qualities in the plasma of the mate.

If, for example, the defect which produces diminutive eyes or eyes of exaggerated size or pig-

mentation of the retina, or albinism or strabismus (cross-eyes), or myopia, or any of the deficiencies to which reference has been made, be united with a plasma in which is the potentiality of a like defect, the double potency thus established will be surely shown in the children through the generations. If on the other hand the quality is recessive or if it is what DeVries has termed a "sport," an accidental happening, while it may perpetuate itself in some of the children, should it be mated with the normal, its effect may in time be so diminished that it will ultimately disappear.

In the case, then, of Elizabeth, the ancestry is apparently free from the defect which so sadly afflicted her brother. Should both parents of their future children have normal eyes, there is every hope that these may escape a calamity so greatly to be dreaded.

We have profited to an enormous extent from the studies in the development of superior qualities in all the lower forms of life. The welfare of the nation demands that the youth of the land should be so instructed in the known facts governing the perpetuation of species that they may not, through ignorance, make such serious errors in the choice of future grandfathers, that unnumbered generations may suffer the consequence of their mistakes.

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What you should know about eyes.

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